# ANNUAL REPORT OF THE ASSISTANT DIRECTOR 1959-1960

NOVEMBER, 1960

NO. 21

by

H.L. MICHAEL

## Joint Highway Research Project

PURDUE UNIVERSITY
LAFAYETTE INDIANA

ANNUAL REPORT OF THE ASSISTANT DIRECTOR, 1959-1960

TO: K. B. Woods, Director
Joint Highway Research Project

November 2, 1960

FROM: H. L. Michael, Assistant Director
Joint Highway Research Project

File: 10-4-[illegible]

Attached is a copy of the "Annual Report of the Assistant Director, 1959-1960". This report, the 22nd in a series, presents the activities of the Joint Highway Research Project during the past year. A very brief summary of the contents of the report is included in this letter of transmittal.

The Project conducted research in eight areas during 1959-60 with thirty-eight (38) research projects being active. Of these studies, ten (10) were completed and nine (9) new projects were initiated. Seven (7) of the completed projects were conducted by staff members who also utilized the research in the preparation of a graduate thesis. The following table lists each of the eight areas and the distribution of active projects, completed projects, theses and new projects.

Research Projects 1959-60

| Research Area | Number of | | | |
|---|---|---|---|---|
| | Active Projects | Projects Completed | Theses | New Projects |
| Airphoto Interpretation | [illegible] | 2 | 1 | 2 |
| Bituminous Materials and Flexible Pavements | 6 | 3 | 2 | 1 |
| Chemistry of Materials | 5* | 1 | 0 | 1 |
| Concrete Materials and Rigid Pavements | [illegible]** | 1 | 0 | 0 |
| Economics, Administration and Finance | 1* | 0 | 0 | 1 |
| Soils and Pavement Design | 7 | 1 | 1 | 2 |
| Traffic Engineering and Safety | 6 | 2 | 2 | 2 |
| Special Projects | 3 | 0 | 1 | 0 |
| TOTAL | 38 | 10 | 7 | 9 |

* One inactive project in 1958-59 was reactivated in 1959-60.
** Two active projects in 1958-59 were inactive in 1959-60.

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Forty-five (45) formal reports were presented to the Advisory Board during the year, totaling 2,044 pages of information. Twenty (20) of these were research reports, ten (10) were technical papers, nine (9) were plans of study and six (6) were administrative reports.

Major research projects which were active included the photogrammetric measurement of final pay quantities in highway construction; an investigation of bituminous concrete stability by the Hveem stabilometer; a study of the shear strength of bituminous mixtures; research on a method for evaluating aggregate gradings; observation of several damp-proofing treatments of bridges; the measurement of deflections in the flexible pavement of the U.S. 31 Test Road; repeated load tests on soil-aggregate mixtures and on the base and subbase materials of the AASHO Test Road; a study of the effects of speed zoning in suburban areas; locating slippery pavement sites from the analysis of accidents; the evaluation of the adequacy of urban intersections; further studies of deleterious substances in Indiana aggregates; an investigation of the fatigue properties of lightweight aggregate concrete; and a study of run-off from small watersheds.

Four of the research projects which were active during the year were cooperative projects between the Bureau of Public Roads and the State Highway Department of Indiana and utilized HPS funds for seventy-six (76) per cent of their total costs. Two of these projects - research on the hydraulics of river flow under small bridges and the measurement of moisture gradients in concrete - were continued from the previous year. Another project, the engineering soils mapping from aerial photographs, was also continued from previous years, but was expanded to include cooperation with those agencies preparing agricultural soils maps in the state and to include typical engineering test data of the soils. This project was first approved during the year as one of the cooperative projects. A new study, the impact of highway improvements on land development and land values, was approved by the Board for a cooperative project and at the end of June [illegible] was awaiting approval by the Bureau of Public Roads.

Highway extension activities continued. The 44th Annual Road School was attended by over 1000 persons and numerous requests for advice and assistance from counties and cities were filled. A new organization, the Highway Extension and Research Project for Indiana Counties, was organized during the year with the cooperation of the County Commissioners of Indiana and with financing provided from county funds by the last legislature. Cooperation with this unit in the area of extension was excellent.

The Project published two significant bulletins during the year: 1), an ATLAS OF COUNTY DRAINAGE MAPS and 2), A STUDY OF HIGHWAY TRANSPORTATION IN INDIANA. The ATLAS marked the completion of the drainage mapping program and 169 copies were distributed, most of them by sale, by June 30. The second bulletin was the final report of the needs study and was distributed throughout Indiana and to interested individuals and groups in other states by the State Highway Department. In addition the

Road School Proceedings, the 1960 Directory of Indiana State, County and City Officials Responsible for Street and Highways, and a monthly newsletter were published by the Project.

Three new members were appointed to the Advisory Board during the year; Mr. F. L. Ashbaucher from the Highway Department and Professors W. H. Goetz and J. F. McLaughlin from Purdue University. Each of these appointments was made to fill an existing vacancy on the Board which had occurred because of retirements and a resignation. Board Members Mills, Vogelgesang and Woods, Secretary Michael attended all of the eight meetings of the Board. Only ten (10) absences at Board meetings from a possible ninety-six (96) were recorded during the year.

On June 30, 1960, the staff of the Project consisted of twelve (12) research engineers, three (3) research associates, six (6) research assistants, fifteen (15) graduate assistants, two (2) service personnel, and three (3) clerical personnel - a total of forty-one (41). Twelve (12) staff members resigned during the year and twelve (12) new members were employed. The three members of the staff with the longest terms of service with the Project are Professor W. H. Goetz, employed May 13, 1936; Mr. Bronson Luttrell, employed August 6, 1938; and Professor K. B. Woods, employed February 1, 1939.

Major items of equipment purchased during the year included an environmental room, a laboratory scale, a torsion balance, an Edison voice-writer, a moisture exudation pressure specimen, several concrete molds, an Amsuron speed meter, and the reconstruction of a moist room.

The Project encumbrances during the year totaled $1[illegible],328.17 of which $12,[illegible] was encumbered on cooperative (HPS) projects. The Project received $150,[illegible].00 from the State Highway Department of Indiana for Project use and was paid $15,112.67 during the year for expenditures made on the HPS projects in this and at the end of the preceding year. A total of $1,791.00 was also received from the sale of drainage maps during the year.

Members of the staff participated in many national and international meetings during the year. Papers were presented at many of these, including national meetings of the Association of Asphalt Paving Technologists, Institute of Traffic Engineers, American Concrete Institute, American Society of Engineering Education, Highway Research Board, American Society of Testing Materials, and American Society of Civil Engineers. Many members of the staff served on committees of several of these organizations. One division and three committees of the Highway Research Board are chaired by members of the Project staff while one members serves on the Executive Committee of that group. Members of the staff also serve as members of the Board of Directors of ASTM and AAPT and as chairmen of Committees of ASTM and ACI.

Numerous honors and recognitions were granted to members of the staff during the past year. Included among those were the continued chairmanship of the AASHO Road Test Advisory Committee by Professor Woods;

the presentation of the Richard L. Templin Award [illegible] to Professor Goetz; the selection of Professor Yoder as a consultant to the Commission of Roads of Southern Rhodesia; the promotion from Assistant to Associate Professor of Professors McLaughlin and Michael and from Instructor to Assistant Professor of Professor [illegible], the election of Professor [illegible] as President-Elect of the Indiana Society of Professional Engineers, and the selection of Professor Woods as a member-at-large of the Division of Engineering and Industrial Research of the National Research Council.

Staff members presented forty-six (46) [illegible], [illegible] seventeen (17) papers and had thirty-eight (38) publications during the year. Two major publications by staff members were the Highway Engineering Handbook edited by Professor Woods with several members of the staff as contributors and the [illegible] Principles of Pavement Design by Professor Yoder.

The attached report outlines all of the details of the research and other activities which have been conducted this year. All of the projects and success which has been presented has been the result of the excellent cooperation and efforts of the Project staff, the understanding cooperation of the Purdue University administration and the officials of the State Highway Department of Indiana, and the wise guidance of the Advisory Board.

Respectfully submitted,

Harold L. Michael

Harold L. Michael, Assistant Director
Joint Highway Research Project

[illegible]

Attachment

cc: J. [illegible] Antrim
J. R. Bell
I. W. Burr
J. R. Cooper
J. W. Delleur
W. L. Dolch
W. H. Goetz
M. J. Gutzwiller
F. F. Havey
G. A. Hawkins
G. A. Leonards
A. I. Johnson
P. [illegible] Johnson
J. F. McLaughlin
R. D. Miles
R. E. Mills
Keith Morris
M. B. Scott
C. E. Vogelgesang
J. L. Waling
[illegible] Wilkey
[illegible] Wilson
[illegible]
E. J. Yoder

# ANNUAL REPORT OF THE ASSISTANT DIRECTOR

## 1959-1960

by
Harold L. Michael
Assistant Director

Joint Highway Research Project
File: 1-2-3

Purdue University
Lafayette, Indiana

November 2, 1960

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# ANNUAL REPORT OF THE ASSISTANT DIRECTOR

## July 1, 1959 to June 30, 1960

## RESEARCHES OF THE JOINT HIGHWAY RESEARCH PROJECT

The Joint Highway Research Project in the School of Civil Engineering is organized to do cooperative research with the State Highway Department of Indiana. Research was initiated on June 1, 1936, and formally authorized by an act of the Indiana State Legislature on March 11, 1937, and amended March, 1949. The purpose of this organization is to make basic studies of materials used in highways; to facilitate economical design, construction, and maintenance of county and state highways; to investigate traffic, safety, and economics; to provide advanced instruction in the fundamentals of highway engineering and related research; and to provide practical experience in construction and maintenance procedures and use of highway materials. The Project is guided by an Advisory Board consisting of five members of the State Highway Department and six members of the staff of the School of Civil Engineering at Purdue University.

The research conducted during the year in eight areas for the State Highway Department was varied and important. Thirty-eight (38) research projects were active and are briefly discussed in the following pages.

# ACTIVE RESEARCH PROJECTS

## Airphoto Interpretation Research

Research under the direction of R. D. Miles

### Application of Airphoto Interpretation in the Determination of Runoff Constants for Small Watersheds (C-36-32N)

Investigator: Merle Parvis

This project is an investigation of drainage basin and stream net characteristics by the use of aerial photographs to determine the values of the constants in design formulas. A study is being made of the attributes of watersheds as they influence runoff. An attempt is being made to develop a procedure for using aerial surveys which can be applied by the bridge engineer.

### Photogrammetric Measurement of Final Pay Quantities in Highway Construction (C-36-320)

Investigator: R. R. Johnson

Qualitative data on final pay items in highway construction were obtained by photogrammetric measurement of aerial photographs. A comparison was made with field measurements made by the State Highway Department of Indiana. Photogrammetric measurements of excavation, embankment, borrow, concrete pavement and appurtenances, guard rail and paved side ditch agreed within 2.5% of field computations. Errors in identification occurred in measuring sodded areas and curbing that preclude the use of photogrammetry for these items.

## County Drainage Maps from Airphotos (C-36-51A)

Investigator: Merle Parvis

Detailed drainage maps were completed for the 92 counties in the State of Indiana. An Atlas was published and contains maps at a scale of one inch equals two miles with a brief description of the county including geology, soils, and drainage features. Individual maps are also available at the scale of one inch equals one mile or one inch equals two miles.

## Indiana Engineering Soils Mapping (C-36-51B)

Investigator: P. T. Yeh

The object of this project is two-fold: First, to investigate and develop the airphoto patterns of soils in the various counties in Indiana; second, to obtain a complete engineering soils map of the state. Engineering soils maps of individual counties are prepared at a scale of one inch equals one mile. Cass and Kosciusko counties were completed this year making a total of 31 engineering soils maps available for distribution. This cooperative project is supported by the Bureau of Public Roads, Soil Conservation Service (USDA) and the State Highway Department of Indiana.

## State Drainage Map (C-36-51J)

Investigator: P. T. Yeh

This is a project undertaken to prepare a State Drainage Map at a scale of one inch equals four miles utilizing individual detailed county drainage maps previously prepared. Sixty counties have been traced onto the state base map.

## Bituminous Materials and Flexible Pavement Research

Research under the direction of W. H. Goetz

### Evaluation of Bituminous Concrete by Repeated Load Test on Slab Type Specimen (C-36-6N)

Investigator: J. H. Dennis

This study has determined that parameters can be obtained from the repeated-load test which give a measure of the deformation characteristics of bituminous concrete surface mixtures. These parameters do not compare with Hveem Stabilometer values since the repeated-load test gives a measure of deformation characteristics for a repeated constant load, while the Hveem Stabilometer test gives a measure of stress transmission characteristics. It was concluded that the results of this investigation were not suitable for evaluating bituminous concrete surface mixtures with respect to rutting and shoving because the specimen density decreased in repeated loading rather than increased as occurs under traffic.

### Shear Strength of Bituminous Mixtures (C-36-6P)

Investigator: J. H. Schaub

The testing phase of this study is essentially complete and a report is in progress. It has been determined that there is a change in volume of a bituminous mixture tested triaxially and that a change in void content is reflected in a change in shear strength. Also, for the test conditions utilized, shear strength is not affected significantly by sample drainage conditions. Further analysis of the data is in progress.

### Investigation of Bituminous Concrete Stability by Hveem Stabilometer (C-36-6R)

Investigator: N. G. Gaudette

The purpose of this study is to investigate the applicability of the Hveem Stabilometer design method utilizing the kneading compactor and the accompanying design criteria to the design of Indiana Al type B surface mixture. If it appears to be required, the study proposes to investigate the changes necessary to fabricate realistic test specimens for the Indiana mixture.

### Laboratory Study of Skid Resistance (C-36-53J)

Investigator: J. F. Stephens

From this laboratory investigation it has been concluded that the skid resistance of fine bituminous mixtures is dependent upon the size, shape and mineral composition of the aggregate particles. Mixes with a range of particle sizes are more skid resistant than one size mixes and the finer mixes are more skid resistant than coarser ones. Angular particles have higher initial skid resistance, but may wear faster and the long-range resistance may be provided equally as well by rounded particles. Silica content above the 40-50% level is desirable, but high silica content is not as important to good skid resistance as is proper gradation and size.

### Bituminous Concrete Pavement Design (C-36-55E)

Investigator: W. H. Goetz

A continuing study is being made of changes in density and Hveem stability of bituminous concrete mixtures under traffic. These test data are also being related to performance. Cooperative laboratory design work on Indiana mixtures is being conducted with the Indianapolis laboratory of the SHDI.

Tests on Cores from U. S. 31 Test Road (C-36-59T)

Investigator: N. G. Gaudette

The height, density and Hveem stability of surface, binder and base courses on the U. S. 31 test road were determined from core samples. Extraction and recovery tests were performed. The data were transmitted to the SHDI and released as a Test Road Memorandum.

## Chemistry of Materials Research

Research under the direction of W. L. Dolch

Dampproofing Treatment of Bridges (C-36-37Z)

Investigator: W. L. Dolch

The dampproofing treatments applied to three bridges of the state highway system are being observed periodically to discover if the treated portions have better durability than the untreated control portions. No differences have been observed so far.

Porosity Characteristics of Aggregates (C-36-47F)

Investigator: W. L. Dolch

During the past year a few supplementary measurements were made on the same samples used in an earlier study. Generally, the additional data supported the earlier conclusions. The project is concerned with the description of the pore structure and associated properties of concrete coarse aggregates. These properties are important to the durability of concrete, particularly in freezing and thawing exposure. The approach used involved the relationships between pore structure and the flow of fluids through these materials; density, porosity, permeability, absorptivity, tortuosity, and water vapor

sorption have been measured. The properties of a model have been calculated from these data. Relationships between field performance and certain of these properties have been found. Studies have been limited to limestone.

Method for Evaluating Aggregate Gradings (C-36-42G)

Investigator: S. Popovics

A theory of the mathematical characterization of the grading of concrete aggregate is being tested. Properties of plastic and hardened concrete are measured for various grading characterizations.

## Concrete Materials and Rigid Pavement Research

Research under the direction of J. F. McLaughlin

Trial of a Method for Improving the Durability of Chert (C-36-18B)

Investigator: S. Popovics

An investigation was made to determine whether calcium silicate, formed by reacting sodium and calcium chloride, would close the pores of chert pieces thus making them more durable in concate. It was found that the method reduced water absorption of the chert when the penetration of the reacting solutions was assisted by heat and vacuum.

Evaluation of Aggregate Durability by Freezing and Thawing Tests of Concrete (C-36-37X)

Investigator: J. F. McLaughlin

A program of cooperative freezing and thawing tests of concrete specimens was conducted by thirteen laboratories using the four ASTM Tentative Methods of Test. Three concrete mixtures were used involving different aggregates and two different air contents. Large variations

in durability were found for the same concrete mixture and for tests by the same method, both within and between laboratories. It was concluded that these methods provide useful procedures for comparing the relative durability of different concretes within a given laboratory; that a wide variation of results in the middle range of durability appears to be a normal characteristic of the methods; that the data do not permit recommending one test method over the others for all purposes; and that the ability of concrete to withstand a severe laboratory freezing-and-thawing test is probable indication of a high degree of durability.

Further Studies of Deleterious Substances in Indiana Aggregates (C-36-42F)

Investigator: R. L. Schuster

This investigation consists of a study of the freeze-thaw durabilities of cherts and shales in Indiana's gravel aggregates. Basic information on these materials is being obtained by petrographic and other laboratory methods and an attempt is being made to correlate this basic information with the results of freeze-thaw tests on concrete beams containing small percentages of the cherts and shales.

Fatigue Properties of Lightweight Aggregate Concrete (C-36-56G)

Investigator: W. H. Gray

This investigation was concerned with studying the fatigue properties of a lightweight aggregate concrete. An expanded shale aggregate was selected for test. Two mix designs were used, one for a "low strength" concrete and one for a "high strength" concrete. Cylindrical specimens three inches in diameter by six inches high were cast from the plastic concrete. Many were tested in static compression to arrive at an estimate of the ultimate static compressive strength of each type of

concrete while others were tested for fatigue in compression at stress levels of 40, 50, 60, 70 and 80 per cent of the previously determined static ultimate strength. A statically sound analysis was insured by using over 40 specimens for the fatigue testing and over 60 specimens for the static testing.

The data from these tests on the various mixes were analyzed and compared. Comparisons were also made between the data obtained in this testing program and results from a similar study in which the fatigue properties of air-entrained and non-air-entrained normal weight concrete were investigated.

## Economics, Administration and Finance Research

Research under the direction of H. L. Michael

### Impact of the Lebanon and Kokomo By-Passes (C-36-64A)

Investigator: V. G. Stover

The effect of the construction of a by-pass around a city is the subject of this research. The effect on land use and development, land value, business, traffic flow, traffic accidents and the general community welfare are specific subjects of concern. The by-passes were constructed in 1950 as non-limited access facilities of two lanes each. Each has since been constructed to four lanes and one of them has been made limited access. The changes which have occurred during the initial construction and the later construction are the subject of this analysis. The study will be continued for several years in an attempt to evaluate long-term effects.

Early Impact of an Interstate Highway (C-36-64B)

Investigator: J. A. Fletcher

The impact of an Interstate highway (Interstate 65 between Lebanon and Indianapolis) which is on a new location approximately parallel but about one-eighth mile distance from U. S. 52 is the subject of this study. The initial changes on land use and development, land value and traffic are being investigated and will be the specific subjects of this study. Data on these items and other factors are also being collected and these data are to be organized in such a manner that they can be readily kept current and that additional studies of longer term effects can be evaluated at later dates. This study is being conducted in cooperation with the State Highway Department of Indiana.

Studies of Partial Takings (C-36-64C)

Investigator: V. G. Stover, J. A. Fletcher, G. A. Ingram, R. L. Crist,
and K. Gondo

The land ownership, land value, and land use changes which occur on the remaining pieces of land after partial takings by the state highway department are the subjects of this research. The information reported will include information on land use and value prior to the construction of the new highway; the situation with regard to partial takings, including appraisals and damages paid; and information as to land use and value at a later date, especially in the event of a sale of all or a part of the remainder. This study is being conducted in cooperation with the State Highway Department of Indiana.

Early Impact of an Urban Highway Improvement (C-36-64D)

Investigator: K. Gondo

The impact of an improvement to a major urban arterial highway in Indiana on land use and development, land value, traffic conditions, and

the community are to be studied in this study. The early effects (during construction and immediately after opening) of this construction will be studied and reported and the data organized in such a manner as to facilitate keeping current and the conduct of later studies. The urban improvement to be studied is a new bridge and its approaches in the Greater Lafayette urban area. This study is being performed in cooperation with the State Highway Department of Indiana

## Soils and Pavement Design Research

Research under the direction of E. J. Yoder

### Statistical Analysis of Soil Sampling (C-36-36A)

Investigator: Delon Hampton

A statistical analysis is being made to determine the variability of soil test data within a soil area of known type, second, a study is being made of the variability of soil test data between soil groups formed under the same conditions, but located in different counties. The data are being gathered and analyzed by the use of soil mechanics theory, airphotos, pedology and statistics. Due to the quantity of testing involved only the glaciated portion of the state is being considered.

### Flexible Pavement Design (C-36-52B)

Investigator: E. J. Yoder

A study of flexible pavement design practices and their application to conditions in Indiana. Various theories of design are being evaluated under conditions and practices in Indiana.

### Deflection Measurements - Flexible Pavement - Test Road U. S. 31 (C-36-52C)

Investigator: R. D. Walker

The project provides for making deflection measurement on the flexible pavements of the U. S. 31 test pavement near Columbus, Indiana. The study is intended to be directly applicable to evaluation of the test pavement and also to yield fundamental data on the load-deflection characteristics of flexible pavements.

### Soil Pressures Under Flexible Pavements (C-36-52D)

Investigator: T. F. McMahon

This project consisted of two parts: Part I, was concerned with the development of a pressure sensitive cell for the measurement of pressures in subgrade material under pavement. SR-4 strain gages cemented to a flexible diaphragm were used for this purpose. Part II, was concerned with the measurement, in model studies, of the pressures in a subgrade and the effects of a layered system on these pressures.

### Interactions of the Effects of Certain Variables on the Stresses and Deflections of Pavements (C-36-52F)

Investigator: E. J. Yoder

This is a theoretical study which will attempt to evaluate the effect of wheel loads, tire pressure and other variables on stresses and deflection of rigid and flexible pavements. Data are presently being accumulated.

### Repeated Load Tests on Soil Aggregate Mixtures (C-36-45Y)

Investigator: R. W. Johnson

Repeated load tests are being made on soil aggregate mixes containing a varying quantity of soil. Three levels of stress are being considered.

Pore pressure and volume changes are measured. The soil-aggregate mixtures are those containing an amount of soil to place them at the border between chossive and non-cohesive materials. The purpose of the study is to evaluate the strength of such materials during repeated loading tests.

### Repeated Load Tests on Base and Subbase Materials from AASHO Test Road (C-36-45H)

Investigator: J. H. Haynes

Tests are being conducted to evaluate the physical properties of base course construction materials used in the AASHO Test Road. Various types of tests, including repeated load tests, are being made to make this evaluation.

## Traffic Engineering and Traffic Safety Research

Research under the direction of H. L. Michael

### Periodic Speed Studies (C-36-10C)

Investigator: D. F. Petty and Neddy Jeuzy

Since 1941, periodic speed studies have been made by the Joint Highway Research Project staff at several locations near Lafayette. Speeds are taken at the same stations each time of free-flowing traffic on tangent sections. In the latest study performed in March 1960, a decrease in the average speed was noted for both passenger cars and trucks on two and four-lane highways from that found in August 1959. The decrease noted was approximately one mile per hour. The purpose of this study is to obtain the trending nature of vehicle speeds on the open highway.

Truck Speed-Weight Studies (C-36-10D)

Investigator: D. F. Petty

Annually, in August, in cooperation with the Highway Planning Survey unit of the State Highway Department of Indiana, speeds and weights of a sample of trucks are obtained. Indiana is only one of several states which conducts such studies under the national direction of the Bureau of Public Roads. These studies are made to evaluate the trends in the speeds and weights of the various classes of trucks which use the highways. The study in Indiana in August 1959 indicated that the speed and weight of single unit trucks had slightly decreased from that noted in 1958, but that both the speed and weight of multiple-unit trucks had increased over that in 1958. The latter increase was approximately two miles per hour and one thousand pounds.

Effects of Speed Zoning in Suburban Areas (C-36-17E)

Investigator: C. M. Elmberg

The effects on speed of roadside developments and of speed limit signs were studied in this project. Roadside development was classified as residential, commercial or industrial and the density of each development was also noted. A major arterial highway entering a suburban area was also subjected to a detailed speed study with no speed limit signs, with speed limit signs erected on the basis of the 85th percentile speed of drivers, and with speed limit signs erected on the basis of a lower percentile speed. The effect on speed of development was found to be very variable but no specific results were obtained. Speed was found to not be affected by the placement of speed limit signs.

### Locating Slippery Pavement Sites from Accident Analysis (C-36-59S)

Investigator: V. G. Stover

The accident reports of accidents which occurred on the major highways in ten counties of Indiana were analyzed to determine if the location of slippery surfaces could be found. Information on the accident reports which was found to be most useful was that which indicated if skidding had occurred anytime during the accident and the location of the accident. It was found that a statistical analysis of this information could, with good accuracy, locate slippery surface sites. Slippery sites thus indicated in the ten counties were also subjected to measurement of their slipperiness by the stopping distance method and an excellent correlation was noted.

### Evaluation of Major Urban Intersections (C-36-17T)

Investigator: W. W. Schenler

The purpose of this research is to develop a measure forrelatively rating the capability of a major intersection to perform its task of handling traffic. The rating will consider the service and structural aspects of the intersection and should be useful in determining the priority of improvements. At present this research is restricted to at-grade intersections which are signalized and a rating is being developed which rates those elements of the intersections which effect the comfort, safety, and ease of the motorist in traversing the intersection. The delay encountered by the motorist at the intersection is being used as a measure of the adequacy of the service provided by the intersection.

### Analysis of School Children Crossing Protection (C-36-17U)

Investigator: F. D. Miller

The purpose of this study is to investigate the school children crossing problem in Indiana and to evaluate the economic and safety

characteristics of the various methods of school children crossing protection. Various methods of warning drivers of school children crossings will be studied relative to their effect on the speed of motorists as they approach such crossings. The cost and value of traffic guards, crossing signs, overpasses and other means of protection are also to be investigated.

## Special Research Projects

### Study of Runoff From Small Watersheds for Highway Drainage Design in Indiana (C-36-62A)

Investigator: I. P. Wu under the direction of J. W. Delleur

The purpose of the research is to study the hydrology of watersheds less than 100 square miles throughout the State of Indiana, to improve the existing methods for estimating the runoff from these watersheds, and to improve the existing methods of design of highway drainage structures servicing small watersheds.

Runoff, rainfall and geomorphological data are being collected, and their statistical analysis is in progress. The study of the hydrodynamics of unsteady overland flow is also in progress.

### Hydraulics of River Flow Under Arch Bridges (C-36-62B)

Investigator: P. F. Biery and H. J. Owen under the direction of
J. W. Delleur

The purpose of the research is to study systematically the hydraulic efficiency of waterways under arch bridges, to provide a criterion for determining the proper clear span of arch bridges so as to compensate for the loss of efficiency at high flows, and to provide a method for computing the backwater upstream of arch bridges.

The preliminary small scale model investigation is complete. The large scale testing is in progress in a tilting flume five feet wide, 64 feet long, built especially for this purpose.

Measurement of Moisture Gradients in Concrete Pavements (C-[illegible])

Investigator: J. R. Bell under the direction of G. A. Leonards

A laboratory study to develop the necessary instruments and methods to permit the insitu measurement of moisture gradients in concrete pavement slabs by non-destructive means. Preliminary studies have indicated that such a device can be developed and that the most promising method is the capacitance moisture meter method.

## TRAFFIC ENGINEERING SERVICES UNIT

In 1954, a unit known as Traffic Engineering Services Unit was organized within the Joint Highway Research Project at Purdue University to provide traffic and transportation engineering services for the city and county governmental units of Indiana. The services offered are primarily advice and counsel on traffic and highway problems on an extension basis. Arrangements may also be made, however, for this Unit to supervise and assist in the conduct and analysis of traffic and highway studies with the cost borne by the governmental unit concerned. The activity of the Unit during the past year has been as follows:

| Item No. | Governmental Unit | Services Rendered | Status |
|---|---|---|---|
| 1 | South Bend | Advice and counsel on techniques for the planning of major arterials in South Bend. | Complete |
| 2 | Vanderburg County | Preliminary work on preparing a rural road classification study. | Inactive |
| 3 | Portage | Advice and counsel on planning the development of this growing city. | Complete |
| 4 | Valparaiso | Advice and counsel on parking needs and thoroughfare requirements of the city. Suggestions for action were made. | Complete |
| 5 | Plainfield | Advice and counsel on the improvement and planning of streets. | Active |
| 6 | Chesterton | Advice and counsel on the provision for and the planning of parking facilities and arterial streets. Suggestions for improvements in Chesterton were made. | Complete |
| 7 | Lafayette | Assisted in the preparation of a major arterial system and in the preparation of a program of improvements. | Active |

| | | | |
|---|---|---|---|
| 8 | West Lafayette | Advice and counsel on the traffic, street street, and parking problems of the city. | Active |
| 9 | Tippecanoe County | Preparation of a county highway classification and road numbering system. | Active |
| 10 | Terre Haute | Request for assistance on traffic study reviewed. Assistance offered, No action followed. | Inactive |
| 11 | Numerous Counties | Advice and counsel on the identification of the roads within the county. A large amount of activity has been guided in this area in cooperation with the Highway Extension and Research Project for Indiana Counties | Active |

The procedure for a city of county to obtain the services of the Unit are well established and all inquiries for services to date have been quickly fulfilled. Acceptance of some of the services has been rejected in a few cases where the city did not wish to expend the funds required.

## PERSONNEL OF JOINT HIGHWAY RESEARCH PROJECT

June 30, 1960

## Advisory Board

| | |
|---|---|
| C. E. Vogelgesang | (State Highway Department of Indiana, Chairman) |
| F. L. Ashbaucher (1) | (State Highway Department of Indiana) |
| J. R. Cooper | (State Highway Department of Indiana) |
| F. F. Havey | (State Highway Department of Indiana) |
| J. E. Wilson | (State Highway Department of Indiana) |
| K. B. Woods | (Purdue), Vice-Chairman |
| W. H. Goetz (1) | (Purdue) |
| G. A. Leonards | (Purdue) |
| J. F. McLaughlin (1) | (Purdue) |
| R. E. Mills | (Purdue) |
| J. L. Waling | (Purdue) |
| G. A. Hawkins (M. B. Scott)(2) | (Purdue) |
| H. L. Michael (3) | (Purdue), Secretary |

(1) Appointed a member of the Board on July 1, 1959

(2) Professor Scott attends as representative of Dean G. A. Hawkins and is a non-voting member.

(3) Non-voting member.

## Record of Meetings and Attendance

The Joint Highway Research Project Advisory Board July 1, 1959 - June 30, 1960

| Meeting No. | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | Total to June 30,60 (while Board Member) | |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | July 1 1959 | Aug 5 1959 | Sept 24 1959 (4) | Nov 24 1959 | Jan 21 1960 | Mar 2 1960 (5) | Apr 22 1960 (6) | June 8 1960 | Present | Absent |
| **Members** | | | | | | | | | | |
| F. L. Ashbaucher (1) | X | X | X | X | X | X | X | A | 7 | 1 |
| J. R. Cooper | X | X | X | X | X | X | A | X | 110 | 22 |
| . H. Goetz (1) | A | X | X | X | X | X | X | X | 7 | 1 |
| . F. Havey | X | X | A | X | X | X | X | X | 153 | [illegible] |
| . A. Leonards | A | X | A | X | X | X | X | X | 34 | 7 |
| . E. Mills | X | X | X | A | X | X | X | X | 76 | 2 |
| J. F. McLaughlin (1) | X | X | A | X | A | X | X | X | 7 | 1 |
| G. E. Vogelgesang (Chm) | X | X | X | X | X | X | X | X | 113 | 2 |
| J. L. Waling | A | X | X | X | X | X | X | X | 32 | [illegible] |
| J. E. Wilson | X | A | X | X | X | X | X | X | 14 | [illegible] |
| . B. Woods (V.Chm) | X | X | X | X | X | X | X | X | 161 | [illegible] |
| . A. Hawkins (M. B. Scott)(2) | X | X | -- | -- | -- | -- | -- | -- | 13 | -- |
| . L. Michael (Sec'y)(3) | X | X | X | X | X | X | X | X | 51 | 0 |

(1) Appointed to Board July 1, 1959.
(2) Non-voting representative of Dean Hawkins. Attends when possible.
(3) Non-voting member.
(4) Mr. Charles Miller attended for Mr. Wilson
(5) Prof. [illegible] attended for Mr. Waling
[illegible]
(6) [illegible]

# Research Staff

## Administrative Staff

K. B. Woods, Director
H. L. Michael, Assistant Director

## Research Engineers

| | |
|---|---|
| J. W. Delleur | (Hydraulics) |
| W. H. Goetz | (In Charge, Bituminous) |
| M. J. Gutzwiller | (Structures) |
| R. W. Johnson | (Soils) |
| J. F. McLaughlin | (In Charge, Concrete) |
| R. D. Miles | (In Charge, Airphoto) |
| Merle Parvis | (Airphoto) |
| R. L. Schuster | (Concrete) |
| P. T. Yeh | (Airphoto) |
| E. J. Yoder | (In Charge, Soils) |

## Research Associates

| | |
|---|---|
| A. K. Branham | (Economics) |
| I. W. Burr | (Statistics) |
| W. L. Dolch | (In Charge, Chemistry) |

## Research Assistants

| | |
|---|---|
| J. deC. Antrim | (Concrete) |
| J. R. Bell | (Soils, Geology) |
| K. H. Dunn | (Concrete) |
| D. F. Petty | (Traffic) |
| J. H. Schaub | (Bituminous) |
| R. D. Walker | (Soils) |

Graduate Assistants

| | | | |
|---|---|---|---|
| F. F. Biery | (Hydraulics) | R. D. Miller | (Traffic) |
| J. W. Fletcher | (Economics) | P. [illegible] | (Bituminous) |
| M. G. [illegible] | (Bituminous) | [illegible] | (Traffic) |
| W. H. Gray | (Concrete) | P. T. [illegible] | (Airphotos) |
| Delon Hampton | (Soils) | V. G. Stover | (Traffic) |
| J. H. Haynes | (Soils) | R. L. Terrel | (Airphoto,<br>Geology) |
| H. C. Joung | (Traffic) | L. C. Tsao | (Soils) |
| | | I. P. Wu | (Hydraulics) |

Service Personnel

| | |
|---|---|
| L. L. Black | (Photographic and Duplicating) |
| W. B. Luttrell | (Shop) |

Clerical Personnel

| | |
|---|---|
| Kay Critchell | (Stenographer) |
| Karen Jack | (Purchasing) |
| Constance Venn | (Typist) |

## Date of Appointment of Present Staff

| Name | Present Title | Appointment |
|---|---|---|
| Antrim, J. deC | Graduate Assistant | September 1, 1956 (A) |
| Bell, J. R. | Research Assistant | September 16, 1951 (B) |
| Biery, P. F. | Graduate Assistant | August 1, 1959 |
| Black, E. L. | Laboratory Technician | November 1, 1953 |
| Branham, A. K. (1) | Research Associate | September 1, 1929 (C) |
| Burr, I. W. (3) | Research Associate | February 1, 1958 |
| Critchell, C. M. | Stenographer | October 6, 1958 |
| Dock, Karen | Purchasing Clerk | September 8, 1959 |
| Delleur, J. W. (2) | Research Engineer | July 1, 1958 |
| Dolch, W. L. (1) | Research Associate | September 15, 1947 |
| Dunn, K. H. | Research Assistant | September 1, 1958 |
| Fletcher, J. A. | Graduate Assistant | September 1, 1959 |
| Gaudette, N. G. | Graduate Assistant | September 1, 1958 |
| Goetz, W. H. (3) | Research Engineer | May 15, 1936 |
| Gray, W. H. | Graduate Assistant | September 1, 1958 |
| Gutzwiller, M. J. (2) | Research Engineer | September 1, 1957 |
| Hampton, Delon | Graduate Assistant | February 1, 1957 |
| Haynes, J. H. | Graduate Assistant | June 1, 1959 |
| Johnson, R. W. | Research Engineer | February 1, 1960 |
| Jouzy, N. C. | Graduate Assistant | September 16, 1959 |
| Luttrell, W. B. | Laboratory Assistant | August 6, 1938 |
| McLaughlin, J. F. (2) | Research Engineer | September 1, 1950 |
| Michael, H. L. (2) | Assistant Director | February 1, 1950 |
| Miles, R. D. (1) | Research Engineer | September 1, 1949 |

| | | |
|---|---|---|
| Miller, F. D. | Graduate Assistant | February 1, 1960 |
| Moavenzadeh, F. | Graduate Assistant | February 1, 1960 |
| Parvis, Merle (2) | Research Engineer | March 1, 1946 |
| Petty, D. F. | Research Assistant | February 1, 1959 |
| Schaub, J. H. | Research Assistant | July 1, 1957 (D) |
| Scherler, W. W. | Graduate Assistant | July 20, 1959 |
| Schuster, R. L. | Research Engineer | February 1, 1957 |
| Scudieri, P. F. | Graduate Assistant | June 1, 1960 |
| Stover, V. G. | Graduate Assistant | September 1, 1953 |
| Terrel, R. L. | Graduate Assistant | February 1, 1960 |
| Tsao, L. C. | Graduate Assistant | September 1, 1958 |
| Walker, R. D. | Research Assistant | September 15, 1953 (E) |
| Wann, C. D. | Typist | February 16, 1959 |
| Woods, K. B. (4) | Director | February 1, 1939 |
| Wu, I. P. | Graduate Assistant | September 1, 1959 |
| Yeh, P. T. | Research Engineer | February 1, 1953 |
| Yoder, E. J. (2) | Research Engineer | September 1, 1949 (F) |

(1) Assistant Professor (3) Professor

(2) Associate Professor (4) Head

A. Resigned May 31, 1957 and reappointed September 1, 1957, then resigned June 14, 1958 and reappointed January 22, 1959.

B. Resigned June 30, 1956 and reappointed February 1, 1958.

C. Resigned August 18, 1941 and reappointed August 1, 1949.

D. Resigned July 31, 1957 and reappointed September 1, 1958.

E. Resigned June 30, 1955 and reappointed August 1, 1957.

F. Resigned December 31, 1947 and reappointed September 1, 1949.

# New Staff Members During Past Year

July 1, 1959 to June 30, 1960

| Name | Rank | Degree Held | School | Date Appointed |
|---|---|---|---|---|
| Biery, P. F. | Graduate Assistant | BSCE 1959 | Purdue University | August 1, 1959 |
| Fletcher, J. A. | Graduate Assistant | BSCE 1957 | Ohio University | September 1, 1959 |
| Gondo, K. | Graduate Assistant | BSE 1957 | University of Tokoyo | September 1, 1959 |
| Johnson, R. W. | Research Assistant | BCE 1950<br>MSCE 1954 | University of Minnesota<br>University of Minnesota | February 1, 1960 |
| Jouzy, N. C. | Research Assistant | BSCE 1951<br>MSCE 1959 | London University<br>Purdue University | September 16, 1959 |
| Miller, F. D. | Graduate Assistant | BSCE 1960 | Purdue University | February 1, 1960 |
| Moavenzadeh, F. | Graduate Assistant | BSCE 1956<br>MSCE 1960 | Teheran University<br>Cornell University | February 1, 1960 |
| Schenler, W. W. | Graduate Assistant | BSCE 1947<br>MSCE 1950 | Purdue University<br>Purdue University | July 20, 1959 |
| Scudieri, P. F. | Graduate Assistant | BSCE 1959 | Duke University | June 1, 1960 |
| Terrel, R. L. | Graduate Assistant | BSCE 1960 | Purdue University | February 1, 1960 |
| Wu, I. P. | Graduate Assistant | BS(Agr)1955 | Taiwan University | September 1, 1959 |
| Deck, Karen | Purchasing | | | September 8, 1959 |

# Staff Resignations During the Past Year

July 1, 1959 to June 30, 1959

| Name | Rank | Degree Held | School | Appointed | Resigned |
|---|---|---|---|---|---|
| Gribbins, P. D. | Research Assistant | BS Marine<br>Trans. 1948<br>BSCE 1952<br>MSCE 1957<br>PhD 1959 | U. S. Merchant<br>Marine Academy<br>University of Alabama<br>Purdue University<br>Purdue University | 2/1/57 | 8/15/59 |
| Deeringer, J. A. | Graduate Assistant | BSCE 1946<br>MSCE 1956 | University of Kentucky<br>University of Kentucky | 6/1/59 | 7/31/59 |
| Elmberg, C. M. | Graduate Assistant | BSCE 1956<br>MSCE 1960 | Chalmers Univ. of Tech.<br>Purdue University | 9/9/58 | 5/31/60 |
| Gondo, K. | Graduate Assistant | BSE 1957 | University of Tokoyo | 9/1/59 | 5/31/60 |
| Johnson, R. R. | Graduate Assistant | [illegible]<br>MSCE 1960 | [illegible]<br>Purdue University | [illegible] | [illegible]/60 |
| McKenzie, M. W. | Graduate Assistant | BS 1936<br>BS 1937 | University of Oklahoma<br>University of Oklahoma | 6/1/59 | 8/31/59 |
| Owen, H. J. | Graduate Assistant | BSCE 1958<br>MSCE 1960 | Purdue University<br>Purdue University | 6/1/58 | 1/31/60 |
| Popovics, S. | Graduate Assistant | BSCE 1944 | Univ. of Budapest(Hungary) | 7/1/57 | 12/31/59 |
| Sooky, A. | Graduate Assistant | Eng.Dipl. 1956 | Tech. Univ. of Budapest | 1/15/59 | 9/1/59 |
| Tsao, L. C. | Graduate Assistant | BS 1953<br>MSCE 1960 | Taiwan College of Engr.<br>Purdue University | 9/1/58 | 8/12/60 |

| Name | Rank | Degree Held | School | Appointed | Resigned |
|---|---|---|---|---|---|
| Brooks, Judy | Stenographer | | | 6/8/59 | 9/1/59 |
| Pribie, Gayle | Purchasing Clerk | | | 6/9/58 | 10/1/59 |

# PUBLICATIONS

## Papers, Bulletins, Reprints, and Theses

## July 1, 1959 to June 30, 1960

## Research Activities Bulletins Engineering Experiment Station*
(From January 1936 to date)

| EES Bull. | Vol. | No. | Date | Publications (inclusive) | Period Covered |
|---|---|---|---|---|---|
| 83 | 25 | 5 | Sept. 1941 | 1P - 45P | Jan. 1936 - June 1941 |
| 89 | 26 | 4 | July 1942 | 46P - 60P | July 1941 - June 1942 |
| 91 | 27 | 6 | Nov. 1943 | 61P - 73P | July 1942 - June 1943 |
| 94 | 29 | 1 | Jan. 1945 | 74P - 91P | July 1943 - June 1944 |
| 96 | 29 | 4 | July 1945 | 92P - 103P | July 1944 - June 1945 |
| 100 | 31 | 1 | Jan. 1945 | 104P - 124P | July 1945 - June 1946 |
| 102 | 31 | 5 | Sept. 1947 | 125P - 157P | July 1946 - June 1947 |
| 107 | 33 | 1 | Jan. 1949 | 158P - 176P | July 1947 - June 1948 |
| 110 | 34 | 2 | Mar. 1950 | 177P - 212P | July 1948 - June 1949 |
| 113 | 35 | 4 | July 1951 | 213P - 243P | July 1949 - June 1950 |
| 116 | 36 | 3 | May 1952 | 244P - 272P | July 1950 - June 1951 |
| 119 | 37 | 3 | May 1953 | 273P - 317P | July 1951 - June 1952 |
| 122 | 37 | 6 | Nov. 1953 | 318P - 345P | July 1952 - June 1953 |
| 123 | 38 | 6 | Nov. 1954 | 346P - 374P | July 1953 - June 1954 |
| 126 | 39 | 6 | Nov. 1955 | 375P - 400P | July 1954 - June 1955 |
| 132 | 40 | 4 | Dec. 1956 | 401P - 442P | July 1955 - June 1956 |
| 136 | 41 | 4 | Dec. 1957 | 443P - 472P | July 1956 - June 1957 |
| 139 | 43 | 1 | Mar. 1959 | 473P - 509P | July 1957 - June 1958 |
| 141 | 44 | 3 | May 1960 | 510P - 535P | July 1958 - June 1959 |

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* Also see EES Bulletin No. 99 which covers a complete listing of publications 1-122P. These Bulletins contain summaries of the various research projects as well as some information on the publications by the staff. The Abstracts Bulletin initiated in 1956 contains a short abstract of each staff publication or thesis.

## Abstracts of Engineering Staff Publications and Theses
(From 1955 to date)

| EES Bull. | Vol. | No. | Date | Includes Publications | Period |
|---|---|---|---|---|---|
| 133 | 41 | 1 | March 1957 | 401P - 442P | July 1955 - June 1956 |
| 137 | 42 | 1 | March 1958 | 443P - 472P | July 1956 - June 1957 |
| 140 | 43 | 2 | June 1959 | 473P - 509P | July 1957 - June 1958 |
| 142 | 44 | 4 | July 1960 | 510P - 535P | July 1958 - June 1959 |

### Bulletins

536P "Atlas of County Drainage Maps, Indiana" by Staff, Airphoto Laboratory, Joint Highway Research Project, Bulletin No. 97, Purdue University, 1959.

537P "A Study of Highway Transportation in Indiana," by Transportation Research Staff, Joint Highway Research Project, Bulletin No. 99, Purdue University, 1959.

### Reprints

538P "Polishing Characteristics of Mineral Aggregates," by J. W. Shupe and R. W. Lounsbury, Proceedings of the First International Skid Prevention Conference, pp. 509-537, August 1959 (Civil Engineering Reprint No. 160).

539P "The Impact of Science on ASTM," by K. B. Woods, Proceedings of the American Society for Testing Materials, Vol. 59, pp. 27-41, 1959 (Civil Engineering Reprint No. 163).

540P "Planning for County Highways." by Harold L. Michael, Proceedings of the 45th Annual Road School, Purdue University, Extension Series No. 100, Vol. 44, No. 2, pp. 131-155, March 1960 (Civil Engineering Repring No. 164).

541P "The Effects of Freezing and Thawing of Prestressed Concrete," by F. E. Musleh and M. J. Gutzwiller, Proceedings of the 45th Annual Road School, Purdue University, Extension Series No. 100, Vol. 44, No. 2, pp. 113-130, March 1960 (Civil Engineering Reprint No. 165).

542P "Hydraulics of River Flow Under Arch Bridges, A Progress Report," by H. J. Owen, A. Sooky, S. T. Husain and J. W. Delleur, Proceedings of the 45th Annual Road School, Purdue University, Extension Series No. 100, Vol. 44, No. 2, pp. 100-112, March 1960 (Civil Engineering Reprint No. 166).

543P "Testing Open-Graded Bituminous Mixtures in the Hveem Stabilometer," by R. A. Hannan and W. H. Goetz, Proceedings of the 45th Annual Road School, Purdue University, Extension Series No. 100, Vol. 44, No. 2, pp. 84-99, March 1960 (Civil Engineering Reprint No. 167).

544P "An Analysis of High Accident Rates," by H. H. Blindauer and H. L. Michael, Proceedings of the 45th Annual Road School, Purdue University, Extension Series No. 100, Vol. 44, No. 2, pp. 69-83, March 1960 (Also Traffic Safety Research Review, Vol. 3, No. 4, Dec. 1959) (Civil Engineering Reprint No. 166).

545P "Triaxial Testing of Bituminous Mixtures," by W. H. Goetz and J. H. Schaub, Special Technical Publication No. 252, American Society of Testing Materials, pp. 51-63. 1959 (Civil Engineering Reprint No. 172).

546P "The Rheological Characteristics of a Sand-Asphalt Mixture," by L. E. Wood and W. H. Goetz, Proceedings of the Association of Asphalt Paving Technologists, Vol. 28, pp. 211-229, 1960 (Civil Engineering Reprint No. 173).

547P "A Laboratory Investigation of Pavement Slipperiness," by J. W. Shupe and W. H. Goetz, Bulletin 219, Highway Research Board, Washington, D. C., pp. 56-73, 1960 (Civil Engineering Reprint No. 174).

548P "Mechanics of Continuously-Reinforced Concrete Pavements," by M. M. Miller, Jr. and M. J. Gutzwiller, Bulletin 238, Highway Research Board, Washington, D. C., pp. 94-104, 1960 (Civil Engineering Reprint No. 175).

## Theses

549P "Photogrammetric Measurement of Final Pay Quantities in Highway Construction," A thesis submitted to the faculty of Purdue University by Russell R. Johnson in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, January 1960.

550P "The Effect of Density on the Repeated-Load Strength Properties of Bituminous Concrete," A Thesis submitted to the faculty of Purdue University by John H. Dennis in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, January 1960.

551P "A Laboratory Investigation of the Phenomenon of Friction as Applied to Fine-Textured Bituminous Paving Mixes," A thesis submitted to the faculty of Purdue University by Jack E. Stephens in partial fulfillment of the requirements for the degree of Doctor of Philosophy, August 1959.

552P "Design of a Pressure Sensitive Cell and Model Studies of Pressures in the Subgrade of a Flexible Pavement System," A thesis submitted to the faculty of Purdue University by T. F. McMahon in partial fulfillment of the requirements for the degree of Doctor of Philosophy, August 1959.

553P "Locating Slippery Highway Surfaces Through Accident Report Analysis," A thesis submitted to the faculty of Purdue University by Vergil G. Stover in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, May 1960.

554P "Effects of Speed Zoning in Suburban Areas," A thesis submitted to the faculty of Purdue University by Curt M. Elmberg in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, May 1960.

555P "Application of the Hveem Stabilometer to the Testing of Open-Graded Bituminous Mixtures," A thesis submitted to the faculty of Purdue University by R. A. [illegible] in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, August 1959.

556P "Design and Construction of Hydraulic Flume and Backwater Effects of Semi-Circular Constrictions in a Smooth Rectangular Channel," A thesis submitted to the faculty of Purdue University by H. J. Owen in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, January 1960.

## Other Publications
(See also list of Reprints)

557P "Soil Engineering Problems on the Quebec North Shore and Labrador Railway" by K. B. Woods, R. W. J. Pryer and W. J. Eden, Bulletin 549, Vol. 60, American Railway Engineering Assn., pp. 669-688, February 1959

558P "Investigation of Banded Sediments Along St. Lawrence North Shore in Quebec," by K. B. Woods and R. W. J. Pryer, Special Technical Publication No. 239, American Society for Testing Materials, pp. 55-70, 1958.

559P Highway Engineering Handbook, Editor-in-Chief, K. B. Woods, McGraw-Hill Book Company, New York, March 1960. (W. H. Goetz was an associate editor and contributors from the JHRP staff were W. H. Goetz, J. F. McLaughlin, H. L. Michael, R. D. Miles, R. D. Walker, E. J. Yoder, and K. B. Woods)

560P "Effect of Pavement Type and Composition on Slipperiness - A Summary of Research in Indiana," Harold L. Michael, Proceedings, First International Skid Conference, Virginia Council of Highway Investigation and Research, Charlottesville, Virginia, August 1959.

50lr "Effect of Rate of Strain on the Strength of [illegible]," Delon Hampton and E. J. Yoder, [illegible], Highway Research Board, 1960.

[illegible] "Soil and Soil-Aggregate Stabilization," [illegible] Institute of Civil Engineering, [illegible]

[illegible] *Principles of Pavement Design*, E. J. Yoder, [illegible] New York, [illegible]

[illegible] "Factors Affecting Characteristics of [illegible]," [illegible] Conference, [illegible]

[illegible] [illegible] Vol. [illegible], No. [illegible]

[illegible] [illegible]

[illegible] [illegible]

[illegible] [illegible] Engineering, [illegible]

Note 1 [illegible] Joint Highway Research Project.

# JOINT HIGHWAY RESEARCH PROJECTS AND ADVISORY BOARD REPORTS
July 1, 1959 to June 30, 1960

| Report and No. | Proj. C-36 | Author | Date | Pages | Figs. | Bk. | Vol. | No. | Pt. | Pg. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1018-Laboratory Study, "Results of Laboratory Study on Cores From U. S. 31 Test Road" | 55F | Gaudette | 7/1 | 17 | 0 | 135 | XXI | 3 | A | 6 |
| 1019-Proposed Budget for Period July 1 - September 30, 1959 | --- | Michael | 7/1 | 8 | 0 | 135 | XXI | 3 | A | 23 |
| 1020-Technical Paper, "Studies of Limestone Aggregates by Fluid-Flow Methods" | 47F | Dolch | 7/1 | 30 | 4 | 135 | XXI | 3 | A | 31 |
| 1021-Technical Paper, "Testing Open-Graded Bituminous Mixtures in the Hveem Stabilometer" | 60 | Hennan<br>Coots | 7/1 | 29 | 12 | 135 | XXI | 3 | A | 63 |
| 1022-Final Report, "Application of the Hveem Stabilometer to the Testing of Open-Graded Bituminous Mixtures" | 60 | Hennan | 7/1 | 114 | 30 | 135 | XXI | 3 | A | 90 |
| 1023-Progress Report No. 2, "Further Studies of Deleterious Substances in Indiana Aggregates" | 46 | Scholer | 7/1 | [illegible] | 4 | 135 | XXI | 3 | A | 20[illegible] |
| 1024-Final Report, "The Determination of Potassium in Cement with Tetraphenyl Boron" | [illegible] | [illegible] | 7/1 | 4 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1025-Progress Report No. 2, "The Feasibility of Measuring the [illegible] Gradients in Concrete Pavement Slabs" | [illegible] | [illegible] | 7/1 | [illegible] | [illegible] | 135 | [illegible] | [illegible] | A | 2[illegible] |

| Report and No. | Proj. C-36 | Author | Date | Pages | Figs. | Bk. | Vol. | No. | Pt. | Pg. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1026-Plan of Study, "The Measurement of Moisture Gradient in Concrete Pavement Slabs - Development of a Capacitance Moisture Meter" | 63H | Bell | 8/5 | 27 | 9 | 135 | XXI | 3 | A | 342 |
| 1027-Plan of Study, "Investigation of Field and Laboratory Bituminous Concrete Stability Using the Hveem Stabilometer and Kneading Compactor" | 6R | Gaudette | 8/5 | 11 | 0 | 135 | XXI | 3 | A | 369 |
| 1028-Bibliography, "Supplement No. 3, Bibliography on Mineral Aggregates, 1957-1958" | --- | Concrete Laboratory Staff | 8/5 | 24 | 0 | 135 | XXI | 3 | A | 380 |
| 1029 Technical Paper, "Planning for County Highways" | 54 | Michael | 8/5 | 38 | 4 | 135 | XXI | 3 | A | 404 |
| 1030-Final Report, "Laboratory Investigation of the Phenomenon of Friction as Applied to Fine-Textured Bituminous Paving Mixtures" | 52J | Stephens | 8/5 | 146 | 32 | 135 | XXI | 3 | A | 442 |
| 1031-Progress Report, "Benkelman Beam Deflection Data on U. S. Test Road" | 52C | Walker | 8/5 | 42 | 0 | 135 | XXI | 3 | A | 608 |
| 1032-Proposed Budget, Period October 1 - December 31, 1959 | --- | Michael | 9/24 | 8 | 0 | 135 | XXI | 3 | A | 653 |
| 1033-Plan of Study, "Tests of a Method of Evaluating Aggregate Gradings" | [illegible] | Papoulas | 9/24 | 9 | 1 | 135 | XXI | 3 | A | 66[illegible] |
| 1034-"Annual Report of Assistant Director, 1958-1959" | --- | Michael | 9/24 | 77 | 0 | 135 | XXI | 3 | A | 670 |

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| 1035-Final Report, "Airphoto Interpretation of Engineering Soils of Cass County, Indiana" | 51B | Decker | 11/19 | 45 | 5 | 136 | XXI | 4 | A | 2 |
| 1036-Progress Report, "Traffic Speed Report No. 67" | 10C | Petty | 11/19 | 21 | 8 | 136 | XXI | 4 | A | 57 |
| 1037-Progress Report, "Traffic Speed Report No. 68, Truck Weight Speed Study" | 10D | Petty | 11/19 | 20 | 6 | 136 | XXI | 4 | A | 78 |
| 1038-Final Report, "Design of a Pressure Sensitive Cell and Model Studies in the Subgrade of a Flexible Pavement System" | 52D | McMahon | 11/19 | 188 | 46 | 136 | XXI | 4 | A | 98 |
| 1039-Final Report, "The Effect of Density on the Repeated Load Strength Properties of Bituminous Concrete" | 6N | Bonnot | 11/19 | 66 | 14 | 136 | XXI | 4 | A | 286 |
| 1040-Technical Paper, "Estimation of Highway Needs for County Primary Road Systems by Sample Survey Methods" | 54AA | Covault<br>Michael | 11/19 | 39 | 7 | 136 | XXI | 4 | A | 352 |
| 1041-Plan of Study, "Evaluation of Major Urban Intersections" | 27F | Schonler | 11/19 | 6 | 0 | 136 | XXI | 4 | A | 392 |
| 1042-Proposed Budget for Period January 1 - March 31, 1960 | --- | Michael | 1/20 | 8 | 0 | 137 | XXII | 1 | A | 2 |
| 1043-Working Plan, "County Engineering Soils Maps" | 51B | Miles | 1/21 | 10 | 0 | 137 | XXII | 1 | A | 16 |

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| 1044-Technical Paper, "Design of a Pressure Sensitive Cell and Model Studies of Pressures in the Subgrade of a Flexible Pavement System" | 52D | McMahon<br>Yoder | 1/21 | 59 | 26 | 137 | XXII | 1 | A | 34 |
| 1045-Technical Paper, "Designing Fine Bituminous Mixtures for High Skid Resistance" | 53J | Stephens<br>Goetz | 1/21 | 41 | 13 | 137 | XXII | 1 | A | 93 |
| 1046-Final Report, "Photogrammetric Measurement of Final Pay Quantities in Highway Construction" | 320 | Johnson | 1/21 | 130 | 7 | 137 | XXII | 1 | A | 134 |
| 1047-Progress Report No. 2, "Design and Construction of Hydraulic Flume and Backwater Effects of Semi-Circular Constrictions in a Smooth Rectangular Channel" | 62B | Owen | 1/21 | 75 | 27 | 137 | XXII | 1 | A | 265 |
| 1048-Final Report, "Locating Slippery Highway Surfaces Through Accident Report Analysis" | 59E | Stover | 3/2 | 99 | 10 | 137 | XXII | 1 | A | 357 |
| 1049-Proposed Budget for Period April 1 - June 30, 1960 | --- | Michael | 3/2 | 8 | 0 | 137 | XXII | 1 | A | 456 |
| 1050-Technical Paper, "Warping Stresses and Deflections in Concrete Pavements - Part II" | 63B | Wiseman<br>Harr<br>Leonards | 3/2 | 34 | 0 | 137 | XXII | 1 | A | 464 |
| 1051-Plan of Study, "Effects of Repeated Loading on the Strength and Deformation Characteristics of Soil-Aggregate Mixtures Employing Tri-Axial Compression Tests" | 45G | Haynes | 3/2 | 10 | 0 | 137 | XXII | 1 | A | 498 |

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| 1052-Technical Paper, "Role of Research in Solving" | --- | Woods | 4/21 | 31 | 0 | 138 | XXIII | 2 | A | 7 |
| 1053-Plan of Study, "Impact of Highway Improvements" | 64 | Fletcher | 4/21 | 15 | 0 | 138 | XXIII | 2 | A | 36 |
| 1054-Proposed Budget for Period July 1 - September 30, 1960 | --- | Michael | 6/8 | 8 | 0 | 138 | XXIII | 2 | A | 63 |
| 1055-Proposed Change in Plan of Study, "Effects of Repeated Loading on the Strength and Deformation of Soil-Aggregate Mixtures Employing Triaxial Compression Tests" | --- | Yoder | 6/8 | 3 | 0 | 138 | XXIII | 2 | A | 71 |
| 1056-Plan of Study, "Pore Water Pressure Parameters During Static and Repeated Load Tests of Soil-Aggregate Base Mixtures" | 45G | Johnson | 6/8 | 13 | 3 | 138 | XXIII | 2 | A | 74 |
| 1057-Final Report, "Airphoto Interpretation of Engineering Soils of Kosciusko County, Indiana" | 51B | Yeh | 6/8 | 44 | 4 | 138 | XXIII | 2 | A | 87 |
| 1058-Final Report, "Effects of Speed Zoning in Suburban Areas" | 17S | Elmberg | 6/8 | 151 | 17 | 138 | XXIII | 2 | A | 131 |
| 1059-Technical Paper, "Locating Slippery Highway Sites by Accident Analysis" | 59M | Stover<br>Michael | 6/8 | 27 | 7 | 138 | XXIII | 2 | A | 282 |
| 1060-Technical Paper, "Photogrammetric Measurement of Final Pay Quantities in Highway Construction" | 320 | Johnson<br>Miles | 6/8 | 24 | 6 | 138 | XXIII | 2 | A | 309 |

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| 1061-Progress Report, "Traffic Speed Report No. 69" | 10C | Jouzy | 6/8 | 22 | 8 | 138 | XXIII | 2 | A | 333 |
| 1062-Progress Report, "Benkelman Beam Deflection Data on U. S. 3 Test Road" | 52C | Walker | 6/8 | 32 | 0 | 138 | XXIII | 2 | A | 355 |

# SUMMARY TABULATION OF RESEARCH PROJECTS

## Status as of June 30, 1960

## KEY TO STATUS NUMBERS

| Key Number | |
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| 1 | Complete--unpublished. |
| 2 | Complete--published (including completed theses). |
| 3 | Incomplete--inactive. |
| 4 | Complete--publication in progress. |
| 5 | Active--incomplete |
| 6 | Being started. |
| 7 | Planned. |

* Resigned

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| 2 | 6-4 | Jackson* | 2 | Test Road No. 1, new series |
| 3 | 6-5 | Jackson* | 2 | Test Road 2 |
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| | 6-6-3 | Kay* | 2 | C--Permeability |
| | 6-6-4 | Mayo* | 2 | D--Compression |
| | 6-6-5 | Schaub* | 3 | E--Compaction on Remolded Clays |
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| | 2-4-2 | Graves* | 1 | B--Patch Materials |
| | 2-4-3 | Graves* | 3 | C--Unconfined Compression Tests |
| | 2-4-4 | Layman* | 2 | D--Unconfined Compression & Squeeze Tests |
| | 2-4-5 | Chen* | 2 | E--Stability |
| | 2-4-6 | McLaughlin | 2 | F--Resurface Mixtures |
| | 2-4-7 | Herrin* | 2 | G--Particle Shape |
| | 2-4-8 | Havers* & Dusenbury* | 2 | H--Rubber Asphalt |
| | 2-4-9 | Osili* | 2 | I--Seal Coats |

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| | 2-4-11 | Oppenlander* | 2 | K-Triaxial Testing at High Pressures |
| | 2-4-12 | Zegarra* | 2 | L--Aggregate Bitumen Mixtures |
| | 2-4-13 | Goetz | 2 | M--Strength by Marshall Test |
| | 2-4-14 | Dennis* | 2 | N--Repeated Load Test Evaluation |
| | 2-4-15 | Wood | 2 | O--Rheological Characteristics |
| | 2-4-16 | Schaub* | 2 | P--Shear Strength |
| | 2-4-17 | Hennen* | 2 | Q--Testing - Hveem Stabilometer |
| | 2-4-18 | Gaudette | 5 | R--Stability Tests-Stabilometer & Compactor |
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| | 2-6-2 | Tyler* | 3 | B--Treated |
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| | 6-9-2 | McClelland* | 2 | B--Large Models |
| | 6-9-3 | Ku* | 2 | C--Capillarity |
| | 6-9-4 | Hittle | 3 | D--Capillary Potential |
| | 6-9-5 | Robertson* | 2 | E--Permeability |
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| | 5-11-5 | Lewis* | 1 | E--Joint Perf. Surv. |
| | 5-11-6 | Lewis* | 1 | F--Load Trans. Device |
| | 5-11-7 | Camp* | 1 | G--Conc. Exp. |
| | 5-11-8 | Melville* | 1 | H--Conc. Exp. |
| | 5-11-9 | Okamoto* | 1 | I--Freeze and Thaw |
| | 5-11-10 | Lewis* | 1 | J--Resurvey of Blowups |
| | 5-11-11 | Schneboli*, Thoma* & Lewis* | 3 | K--Strain Gauges |
| | 5-11-12 | Choksi* | 2 | L--Structural Design Bibliography |
| | 5-11-13 | Miller* | 2 | M--Theoretical Strains & Stresses |
| 47 | 4-6 | | | Chemistry of Concrete |
| | 4-6-1 | Slate* | 3 | A--Gels |
| | 4-6-2 | | 3 | B--Thin Sections |
| | 4-6-3 | Dolch | 3 | C--Solubility of Aggregates |
| | 4-6-4 | Slate* | 2 | D--Bibliography |
| | 4-6-5 | Fox* | 2 | E--Thermal |
| | 4-6-6 | Dolch | 2 | F--Aggr. Voids |
| | 4-6-7 | Dolch | 2 | G--Alkali Aggregate Reaction |
| 48 | 9-5 | | | Turf Studies |
| | 9-5-1 | Yoder | 2 | A--Early Studies |

| Project C-36 | File No. | Assigned to | Status (See Key) | Title of Project |
|---|---|---|---|---|
| 49 | | | | |
| 50 | 6-19 | | | Soil Stabilization |
| | 6-19-1 | Slosser* | 1 | A--Chemical |
| | 6-19-2 | Hills* | 1 | B--Molasses |
| | 6-19-3 | Johnson*, Dolch, & Yoder | 1 | C--Lime |
| | 6-19-4 | Sharma* | 2 | D--Bibliography |
| | 6-19-5 | Korman* | 2 | E--Soil Cal. Chloride Mix |
| | 6-19-6 | Yoder | 1 | F--Test Road Using DDAC |
| 51 | 1-5 | | | Soil, Drainage Mapping |
| | 1-5-1 | Parvis, Yeh Magnusson* | 2 | A--Drainage Maps |
| | 1-5-2 | Montano*, Yeh | 5 | B--Soils Maps |
| | 1-5-3 | Moultrop* | 2 | C--Loess Mapping |
| | 1-5-4 | McLerran* | 2 | D--SW Indiana Interbedded Shale |
| | 1-5-5 | | | E-- |
| | 1-5-6 | Stylianopoulous* | 2 | F--SS and Shale of SW Indiana |
| | 1-5-7 | Robbins* | 2 | G--LS and Shale of SE Indiana |
| | 1-5-8 | Leighty* | 2 | H--Alluvial Terraces |
| | 1-5-9 | McGregor* | 2 | I--Agriculture Soil Map Use |
| | 1-5-10 | Yeh | 5 | J--State Drainage Map |
| | 1-5-11 | Montano*, Yeh | 2 | K--State Soils Map |
| | 1-5-12 | Dawson* | 2 | L--SS and Shale of SC Indiana |
| | 1-5-13 | Van Til* | 2 | M--LS of SC Indiana |
| | 1-5-14 | Stevens* | 2 | N-- Illinoian Glacial Drift, SE Indiana |
| | 1-5-15 | Johnson* | 2 | O--Northern Indiana Sands |
| | 1-5-16 | Richert* | 2 | P--SS and Shale Areas |
| | 1-5-17 | Davis* | 2 | Q--NW Indiana Moraines |
| | 1-5-18 | Mintzer* | 2 | R--Illinoian Glacial Drift, SW Indiana |
| 52 | 6-20 | | | Pavement Design |
| | 6-20-1 | Ardaman* & Yoder | 2 | A--C.B.R. Tests |
| | 6-20-2 | Yoder | 5 | B--Flexible Pavement Design |
| | 6-20-3 | Walker | 5 | C--Deflection U. S. 31 Test Road |
| | 6-20-4 | McMahon* | 2 | D--Soil Pressures Under Flexible Pvts. |
| | 6-20-5 | Walker | 3 | E--Repetitive Loading Tests |
| | 6-20-6 | Ruth & Yoder | 5 | F--Interaction of Variables on Stresses |
| 53 | 9-6 | | | Road Roughness & Skid |
| | 9-6-1 | Metcalf*, Thanos*, Holloway* | 2 | A--Equipment, Roughness |
| | 9-6-2 | Grunau*, Baerwald* | 2 | B--Skid Resistance Equipment |
| | 9-6-3 | McLaughlin | 1 | C--Skid Characteristics Bibliography |

| Project C-36 | File No. | Assigned to | Status (See Key) | Title of Project |
|---|---|---|---|---|
| | 9-6-4 | Shupe* | 2 | D--Bit. Mixture Skid Characteristics |
| | 9-6-5 | Grunau*, Michael, Shupe* | 2 | E--Skid Resistance of U. S. 31 Test Road |
| | 9-6-6 | Rosenfield*, Weckesser* | 2 | F--Lateral Placement of U. S. 31 Test Rd. |
| | 9-6-7 | Grunau*, Michael | 2 | G--Skidding Characteristics, Ind. |
| | 9-6-8 | Grunau*, Shupe* | 2 | H--Skid Tests on U. S. 421 |
| | 9-6-9 | Holloway* | 2 | I--Roughness Characteristics |
| | 9-6-10 | Stephens* | 2 | J--Effects of Aggregate on Skidding |
| 54 | 3-3 | | | Econ. & Admin. |
| | 3-3-1 | Michael | 3 | A--Wabash River Bridge |
| | 3-3-2 | May* | 2 | B--Lebanon Bypass |
| | 3-3-3 | Michael | 2 | C--Kokomo Bypass |
| | 3-3-4 | Baerwald* | 2 | D--Public Opinion Poll |
| | 3-3-5 | Branham*, Baerwald* | 2 | E--County Road Marking |
| | 3-3-6 | Branham*, Baerwald* | 3 | F--Cost Allocation |
| | 3-3-7 | May* & Yoder | 3 | G--Air Transportation |
| | 3-3-8 | May* | 3 | H--Laf. Trans. Study |
| | 3-3-9 | May* | 2 | I--Logansport Study |
| | 3-3-10 | Michael | 2 | J--Richmond Study |
| | 3-3-11 | Michael | 3 | K--Bloomington Study |
| | 3-3-12 | Bauer* | 3 | L--Logansport Parking |
| | 3-3-13 | Kell* | 2 | M--O-D Surv. Methods |
| | 3-3-14 | Stoner*, Petty,* Woods & Branham* | 2 | N--Co. Highway Admin. |
| | 3-3-15 | Miller* | 2 | O--Sampling Techniques |
| | 3-3-16 | Baerwald* | 2 | P--County Classification |
| | 3-3-17 | Michael & Edwards* | 2 | Q--Huntington Survey |
| | 3-3-18 | Baerwald* | 2 | R--Allen Co. Study |
| | 3-3-19 | Branham* | 2 | S--Recruitment of Engineers |
| | 3-3-20 | Michael | 2 | T--State Highway Needs Study |
| | 3-3-21 | May* | 2 | U--Evaluation of Limited Access Highways |
| | 3-3-22 | Barr* | 2 | V--Urban Characteristics for O-D Surveys |
| | 3-3-23 | Cribbins* | 2 | W--Northern Indiana Seaport |
| | 3-3-24 | Branham* | 2 | X--Engineer Retention Study |
| | 3-3-25 | Kask* | 2 | Y--W. Lafayette Shopping Center Study |

| Project C-36 | File No. | Assigned to | Status (See Key) | Title of Project |
|---|---|---|---|---|
| | 3-3-26 | Pinnell* | 2 | Z--Bypass Reevaluation Studies |
| | 3-3-27 | Covault* | 2 | AA--Sampling for County Needs |
| 55 | 2-12 | | | Flex. Pavement Design |
| | 2-12-1 | Goetz | 5 | A--General |
| | 2-12-2 | Lowrie* | 2 | B--Design |
| | 2-12-3 | Metcalf* | 3 | C--Test Road, Churubusco |
| | 2-12-4 | Herrin* | 3 | D--Thickness Design |
| | 2-12-5 | McLaughlin, Goetz | 5 | E--Bituminous Concrete |
| | 2-12-6 | Goetz, Gaudette | ~~5~~ 2 | F--U. S. 31 Test Road Cores |
| 56 | 7-4 | | | Bridges |
| | 7-4-1 | McCammon* | 3 | A--Dynamic Forces |
| | 7-4-2 | Hayes, Sbarounis* | 2 | B--Vibration |
| | 7-4-3 | | 3 | C--Soil Pressure, U-Type Bridge |
| | 7-4-4 | Miles | 2 | D--Bridge Site Topo Maps, Photogrammetry |
| | 7-4-5 | Wyly* | 3 | E--Design of Washers for High Tensile Bolts |
| | 7-4-6 | Antrim | 2 | F--Fatigue Properties |
| | 7-4-7 | Gray | 5 | G--Fatigue Properties, Light Weight Concrete |
| 57 | 5-12 | | | Cement |
| | 5-12-1 | Blackburn* | 1 | A--Slag Cement, Durability of Concrete |
| 58 | 5-13 | | | Prestressed Concrete |
| | 5-13-1 | Midgaard* | 2 | A--Creep & Shrinkage |
| | 5-13-2 | | | B-- |
| | 5-13-3 | Musleh* | 2 | C--Freeze & Thaw Affects |
| 59 | 8-5 | | | Traffic Safety |
| | 8-5-1 | Michael | 3 | A--Crash Injury |
| | 8-5-2 | Michael | 3 | B--Safety Belts |
| | 8-5-3 | Woo* | 2 | C--Accident Rate vs. Design Features |
| | 8-5-4 | Blindauer* | 2 | D--High Accident Rates |
| | 8-5-5 | Stover | 2 | E--Locating Slippery Pavements from Accident Reports |
| 60 | 3-4 | | | Highway Cost Studies |
| | 3-4-1 | Balcher* | 1 | A--Mass Diagram |
| | 3-4-2 | Mylroie* | 3 | B--Receipts and Disbursements, N. C. States |

| Project C-36 | File No. | Assigned to | Status (See Key) | Title of Project |
|---|---|---|---|---|
| 61 | 5-14 | | | Concrete Characteristics |
| | 5-14-1 | McLaughlin | 3 | A--Temp. Effect on Air Bubble Distribution |
| 62 | 9-8 | | | Hydraulics |
| | 9-8-1 | Delleur | 5 | A--Runoff from Small Drainage Areas |
| | 9-8-2 | Delleur, Owen, Sooky*, Hussain* | 5 | B--Hydraulics of Arch Bridges |
| 63 | 9-7 | | | Pavement Deflection |
| | 9-7-1 | Geldmacher*, Anderson*, Dunkin*, Wood, Harr | 2 | A--Pavement Deflection |
| | 9-7-2 | Harr | 2 | B--Environmental Effects |
| | 9-7-3 | Bell | 5 | C--Measurement of Moisture in Concrete |
| 64 | 3-5 | | | Impact Studies |
| | 3-5-1 | Stover | 5 | A--Lebanon-Kokomo Bypasses |
| | 3-5-2 | Fletcher | 5 | B--I65, Lebanon to Indianapolis |
| | 3-5-3 | Michael | 5 | C--Studies of Partial Takings |
| | 3-5-4 | Condo | 5 | D--Laf.-W. Laf. Wabash River Bridge |

# EXTRA LABOR EMPLOYEES

## Supplement No. 6*

## Termination Between July 1, 1959 and June 30, 1960

| Employee | Employed | Resigned |
|---|---|---|
| Akinwumi, A. A. | 7/1/59 | 8/31/59 |
| Bellamy, L. A. | 7/1/59 | 12/31/59 |
| Bergman, P. | 7/1/59 | 7/15/59 |
| Biery, P. F. | 7/1/59 | 7/15/59 |
| Bingman, E. A. | 2/1/60 | 5/31/60 |
| Brahma, S. P. | 11/1/59 | 6/15/60 |
| Brodie III, R. | 3/1/60 | 4/30/60 |
| Burgess, R. R. | 6/1/60 | 6/30/60 |
| Busch, G. E. | 6/1/60 | 6/15/60 |
| Chambers, B. E. | 7/1/59 | 7/15/59 |
| Chang, T. P. | 5/15/60 | 5/31/60 |
| Charyulu, V. P. | 9/1/59 | 10/31/59 |
| Chastain, L. E. | 7/1/59 | 7/15/59 |
| Crabtree, B. L. | 3/15/60 | 5/31/60 |
| Day, J. A. | 7/1/59 | 7/15/59 |
| Derr, R. L. | 6/15/60 | 6/30/60 |
| Desrosier, F. L. | 7/1/59 | 7/30/59 |
| Dinges, K. N. | 12/1/59 | 1/13/60 |
| Diskerud, T. C. | 7/1/59 | 1/15/60 |
| Dix, O. H. | 4/15/60 | 6/15/60 |
| Equers, P. R. | 8/1/59 | 6/30/60 |
| Eriksen, E. | 12/15/59 | 2/15/60 |
| Farouk, M. A. | 8/15/59 | 8/31/59 |
| Felter, B. D. | 11/1/59 | 5/15/60 |
| Fieting, R. D. | 4/1/60 | 6/15/60 |
| Freedman, B. M. | 9/15/59 | 6/30/60 |
| Gallagher, P. F. | 11/15/59 | 1/15/60 |
| Garcia, D. | 3/1/60 | 6/15/60 |
| Garrett, C. K. | 7/1/59 | 7/30/59 |
| Glans, C. L. | 6/1/60 | 6/30/60 |
| Gurnani, N. U. | 2/1/60 | 4/30/60 |
| Halicki, R. J. | 7/1/59 | 7/15/59 |
| Hamilton, R. R. | 7/1/59 | 9/30/59 |
| Hanssen, S. N. | 7/1/59 | 12/31/59 |
| Hauser, R. B. | 4/1/60 | 6/15/60 |
| Herbenar, J. | 3/1/60 | 6/15/60 |
| Hope, James W. | 2/15/60 | 2/29/60 |

| Employees | Employed | Resigned |
|---|---|---|
| Inouye, R. | 9/15/59 | 10/31/59 |
| Johnson, J. A. | 6/15/60 | 6/30/60 |
| Kerchaert, E. J. | 7/1/59 | 12/15/59 |
| Kestner, M. A. | 10/1/59 | 1/15/60 |
| Khosrovani, H. | 8/1/59 | 8/15/59 |
| Kwock, P. K. B. | 7/15/59 | 12/15/59 |
| Lancaster, L. D. | 2/1/60 | 6/30/60 |
| Lippai, S. | 7/1/59 | 5/31/60 |
| Lobo, C. T. | 8/15/59 | 6/30/60 |
| Mahmoud, K. S. | 6/1/60 | 6/30/60 |
| Martin, D. W. | 6/15/60 | 6/30/60 |
| Martin, P. A. | 6/15/60 | 6/30/60 |
| Matrai, L. | 12/15/59 | 1/15/60 |
| Morton, C. V. | 7/1/59 | 7/30/59 |
| Nakashima, R. Y. | 7/1/59 | 7/30/59 |
| Nicklas, J. L. | 6/15/60 | 6/30/60 |
| Nguyen, D. H. | 10/1/59 | 1/31/60 |
| Niemeyer, J. E. | 12/1/59 | 12/15/59 |
| Norman, R. E. | 10/15/59 | 5/31/60 |
| Ozdural, B. | 12/15/59 | 12/31/59 |
| Pai-Pandiker, S. A. | 8/1/59 | 8/31/59 |
| Panahpour, Y. | 8/1/59 | 8/15/59 |
| Pfalzer, J. L. | 10/1/59 | 12/30/59 |
| Reddy, A. S. | 2/15/60 | 5/15/60 |
| Russell, G. E. | 11/1/59 | 5/31/60 |
| Shah, G. N. | 7/1/59 | 11/30/59 |
| Shehadeh, N. M. | 2/1/60 | 5/31/60 |
| Slogedal, A. | 12/1/59 | 12/15/59 |
| Spencer, R. E. | 4/1/60 | 6/15/60 |
| Steele, R. W. | 9/15/59 | 9/30/59 |
| Surface, D. E. | 4/1/60 | 6/15/60 |
| Syron, S. | 7/1/59 | 12/30/59 |
| Swing, J. P. | 6/15/60 | 6/30/60 |
| Terrel, R. L. | 10/1/59 | 1/31/60 |
| Ullstrup, P. | 6/15/60 | 6/30/60 |
| Vargas, A. | 10/15/59 | 12/30/59 |
| Villigas, O. | 3/15/60 | 6/15/60 |
| Virgin, B. D. | 2/15/60 | 2/29/60 |

| Employees | Employed | Resigned |
|---|---|---|
| Wonaas, D. | 6/16/60 | 6/30/60 |
| Wildin, M. W. | 8/15/59 | 8/30/59 |

* For listing of all terminations prior to July 1, 1954, see the "Annual Report of the Associate Director for 1953-54". For terminations after July 1, 1954 see the Annual Reports of the Assistant Director for 1954-1955, 1955-1956, 1956-1957, 1957-1958, and 1958-1959.

## Still Employed on July 1, 1960

| Employees | Employed |
|---|---|
| Allen, R. K. | 3/31/60 |
| Andrews, P. R. | 3/31/60 |
| Appleman III, D. R. | 9/15/59 |
| Clouser, P. T. | 4/15/60 |
| Donaldson, F. E. | 9/15/59 |
| Egyed, A. N. | 4/15/60 |
| Hart, K. E. | 3/15/60 |
| Marsland, S. | 3/1/60 |
| Norton, L. N. | 6/15/60 |
| Orjuela, H. | 2/15/60 |
| Schnarr, G. R. | 2/1/60 |
| Schwenk, T. D. | 2/15/60 |
| Servis, K. L. | 1/15/60 |
| Tsengos, M. G. | 4/1/60 |
| Zieck, N. | 6/15/60 |
| Zimmer, R. W. | 3/15/60 |